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David Martin

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IMAGE COMPRESSION BEFORE BAYER DEMOSAICING

BACKGROUND

In the typical image processing pipeline in a camera system, a raw Bayer image is first demosaiced to RGB and then afterwards processed and compressed. The resultant file may be, for example, a JPEG file. Image processing may introduce loss, and so when one is interested in the original raw pixels, it may be desirable to move image processing off the camera for post-processing. Post-processing may be performed on more a powerful processor, for example, in a PC. In professional cameras, this may be accomplished by storing the totally raw Bayer image data, and doing all image processing in post-processing. The raw (Bayer) files tend to be relatively large. For example, raw files may be ten times larger than average JPEG files.

In many domains, such as most commercial cameras, image compression is not optional. However, compression chips that are used in the domains, such as those used for H.264/AVC or H.265/HEVC, often require raw data to be highly processed before inputting into the compression chip. Many standard image compression algorithms, for example, do not take Bayer image data as input, but rather require the raw Bayer image data to be converted to a specific format, such as 10-bit Y’CbCr 4:2:2, before compression.

One well-known option for compressing Bayer images direction is to compress each Bayer channel separately using a monochrome compression, such as in JPEG compression. In monochrome compression, the four Bayer channels (red, green 1, green 2, and blue) are deinterleaved to form four half-resolution grayscale images. After applying a non-linear transform to get the desired bit depth, the half-resolution grayscale images may then be compressed in Y’4:0:0 mode. However, the image constructed from the four half-resolution grayscale images after compression contains many artifacts as a result of the compression.

BRIEF SUMMARY

This disclosure presents compression of a raw bayer image using standard compression hardware that preserves more data from the raw bayer image such as by only interpolating the green channel prior to compression. As a result, high quality images may be produced with little to no artifacts in post-processing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a pictorial diagram of an example implementation of formatting Bayer channels from a raw Bayer image for compression in accordance to aspects of the disclosure.

FIGURE 2 is a pictorial diagram of an example of resultant channels for compression in accordance to aspects of the disclosure.

FIGURE 3 is a pictorial diagram of another example of resultant channels for compression in accordance to aspects of the disclosure.

FIGURE 4 is a functional diagram of an example image capture system configured to process raw Bayer images in accordance to aspects of the disclosure.

DETAILED DESCRIPTION

Many image sensors capture color information using a color filter array that is arranged on the image sensors, allowing each pixel of the image sensor to capture color information for one color. Color filter arrays may be arrangements of red, green, and blue color filters. Most commercial digital cameras, camcorder, scanners, etc. use a Bayer filter mosaic as the color filter array. A Bayer filter mosaic may be arranged with odd rows of alternating red and green filters and even rows of alternating green and blue filters. As shown in FIGURE 1, Bayer mosaic 110 has eight rows and eight columns. Rows 1, 3, 5, and 7 of Bayer mosaic 110 contain four red filters R and four green filters G1 in an alternating pattern. Rows 2, 4, 6, and 8 of Bayer mosaic 110 contain four green filters G2 and four blue filters B in an alternating pattern. In a given 2x2 tile cluster in the mosaic, there are two green filters G1, G2 arranged diagonally in relation to one another, one red filter R, and one blue filter B. As a result, the amount of green color information captured by a Bayer mosaic may be double that of red or blue color information.

When capturing an image, the pixels of the image sensor covered by a red filter captures red color information; those covered by a blue filter captures blue color information; and those covered by a green filter captures green color information.

The red channel, blue channel, and green channel may be deinterleaved from the raw Bayer image data. This is different from monochrome compression described in paragraph 3, which further separates the green color information from the odd rows and the even rows. In the example shown in FIGURE 1, monochrome compression would process the G1 green color information in the raw Bayer image 110 and the G2 green color information in the raw Bayer image 110 separately.

As a result of the deinterleaving of the raw Bayer image data, two half-resolution grayscale images are created. One half-resolution grayscale image includes red color information, and the other includes blue color information. For example, as shown in FIGURE 1, the red channel 120 includes only the red pixels from the raw Bayer image 110. Since red color information comprises a fourth of the pixels in the raw Bayer image, a half-resolution image 130 including only red color information may be formed. In the same way, the extraction of the blue image using the blue pixels results in a half-resolution grayscale image representing the blue color information.

The green channel may be interpolated, or de-Bayered, to create a dense green channel having green color information for every pixel in the image. Any method of interpolation may be used to determine the green color information for each pixel in the image. As shown in FIGURE 2, the green channel 140 includes both G1 and G2 green pixels. Using the green color information from the G1 and G2 green pixels, green color information may be determined for pixels that were covered by red or blue filters. This results in a dense green channel 150 that includes green color information G3 on every pixel of the image that was covered by red or blue filters. From the dense green channel 150, a full-resolution grayscale image representing the green color information may be formed.

An operation, such as a non-linear transform, may then be performed to convert each channel to the desired bit depth for compression. For example, in H.264 and H.265 compression image coding, 8-bit or 10-bit color may be the expected bit depth.

Once converted, the half-resolution grayscale images for red and blue color information and the full-resolution grayscale image for green color information may be compressed using standard compression image coding. The full-resolution grayscale image with the green color information may be treated as the luma, or brightness, channel. The half-resolution grayscale images for red and blue color information may be treated as the chroma, or color, channels. As shown in FIGURE 2, in compression, dense green channel 150, half-resolution image 130, and half-resolution image 210 may be treated as the luma channels. The channels 150, 130, and 210 each match the Y'4:0:0 mode of standard compression chips. Compression of this data typically results in mild artifacts in comparison with compression standards like JPEG.

Alternatively, the color information may be used to derive chrominance data by taking the difference between the interpolated green values and the red or blue color information, similar to the chrominance components in invertible CbCr color transform, or reversible color transform. After the green interpolation discussed in connection with FIGURE 1, pixels with red color information also have green color information. The difference between the green color information and the red color information on these given pixels may be taken to derive the red-difference chroma. Similarly, pixels with blue color information also have green color information after interpolation. Taking the difference between the green color information and the blue color information on these pixels results in the blue-difference chroma. As shown in FIGURE 3, the dense green channel 150 is compressed as the luma channel, while the difference between green color information G3 and red color information R or blue color information B of given pixels result in the red-difference chroma channel 310 and the blue-difference chroma channel 320, respectively. The channels 150, 310, and 320 match the Y'CbCr 4:2:0 mode of standard compression chips. When compressed, typically few to no artifacts are introduced in compression of this data.

The result of processing raw Bayer image as disclosed above may be relatively quick and inexpensive way to preserve most of the color information from the raw Bayer image for post-processing. The described process converts the data to a format that standard compression chips or other hardware would be able to compress while preserving the bulk of the color information for post-processing. Notably, no color space conversion may be done in hardware, which allows sophisticated deBayering to be performed in software. In this way, images may be compressed, stored, and transferred without expensive or extensive processing. Because less processing may be required, the hardware used can be less powerful and smaller in size.

The processing may be implemented in an image capture system comprising one or more image sensors, a Bayer filter mosaic, one or more processors, a compression chip, and a memory. The Bayer filter mosaic may be overlaid on the one or more image sensors. The one or more processors may include the compression chip and be configured to receive raw Bayer image data from the one or more image sensors. The compression chip may perform a particular compression image coding. As described above, the one or more processors may convert the raw Bayer image data to a format that is a recognizable input to the particular compression image coding prior to inputting the formatted data into the compression chip. The memory may then store the compressed data that is output by the compression chip. For example, image capture system 410 shown in FIGURE 4 comprises image sensor(s) 420, bayer filter mosaic 430, processor(s) 440, compression chip 450 included on the processor(s) 440, and memory 460. The compression chip 450 performs H.265 compression image coding and accepts Y'CbCr 4:2:0 format for compression.

Although the aspects of the technology herein has been described with reference to particular embodiments, it may be to be understood that these embodiments are merely illustrative of the principles and applications of the present technology. Numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present disclosure.

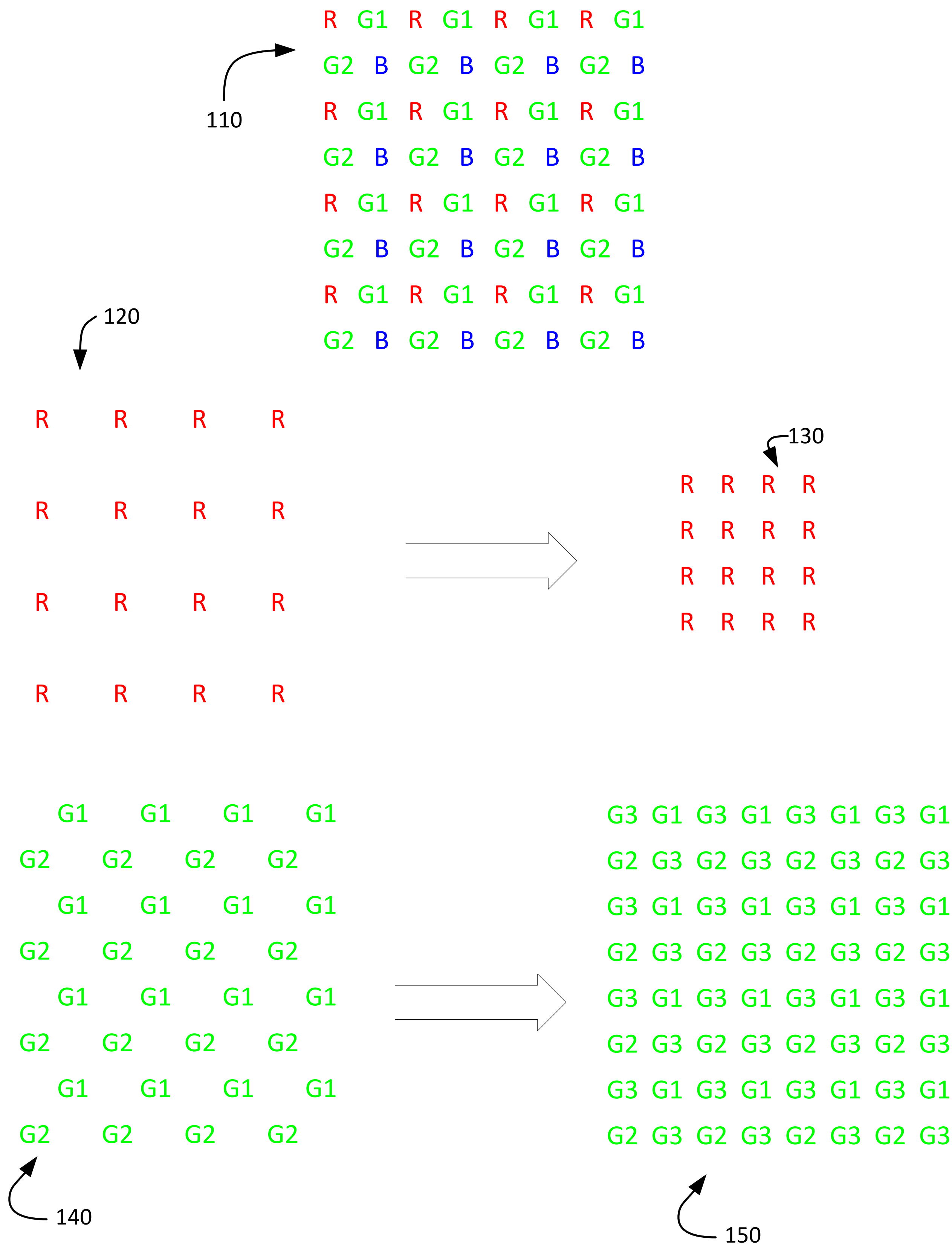
110
R G1 R G1 R G1 R G1
G2 B G2 B G2 B G2 B
R G1 R G1 R G1 R G1
G2 B G2 B G2 B G2 B
R G1 R G1 R G1 R G1
G2 B G2 B G2 B G2 B
R G1 R G1 R G1 R G1
G2 B G2 B G2 B G2 B
120
R R R R
R R R R
R R R R
R R R R
130
R R R R
R R R R
R R R R
R R R R
G1 G1 G1 G1
G2 G2 G2 G2
G1 G1 G1 G1
G2 G2 G2 G2
G1 G1 G1 G1
G2 G2 G2 G2
G1 G1 G1 G1
G2 G2 G2 G2
140
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
150

FIGURE 1

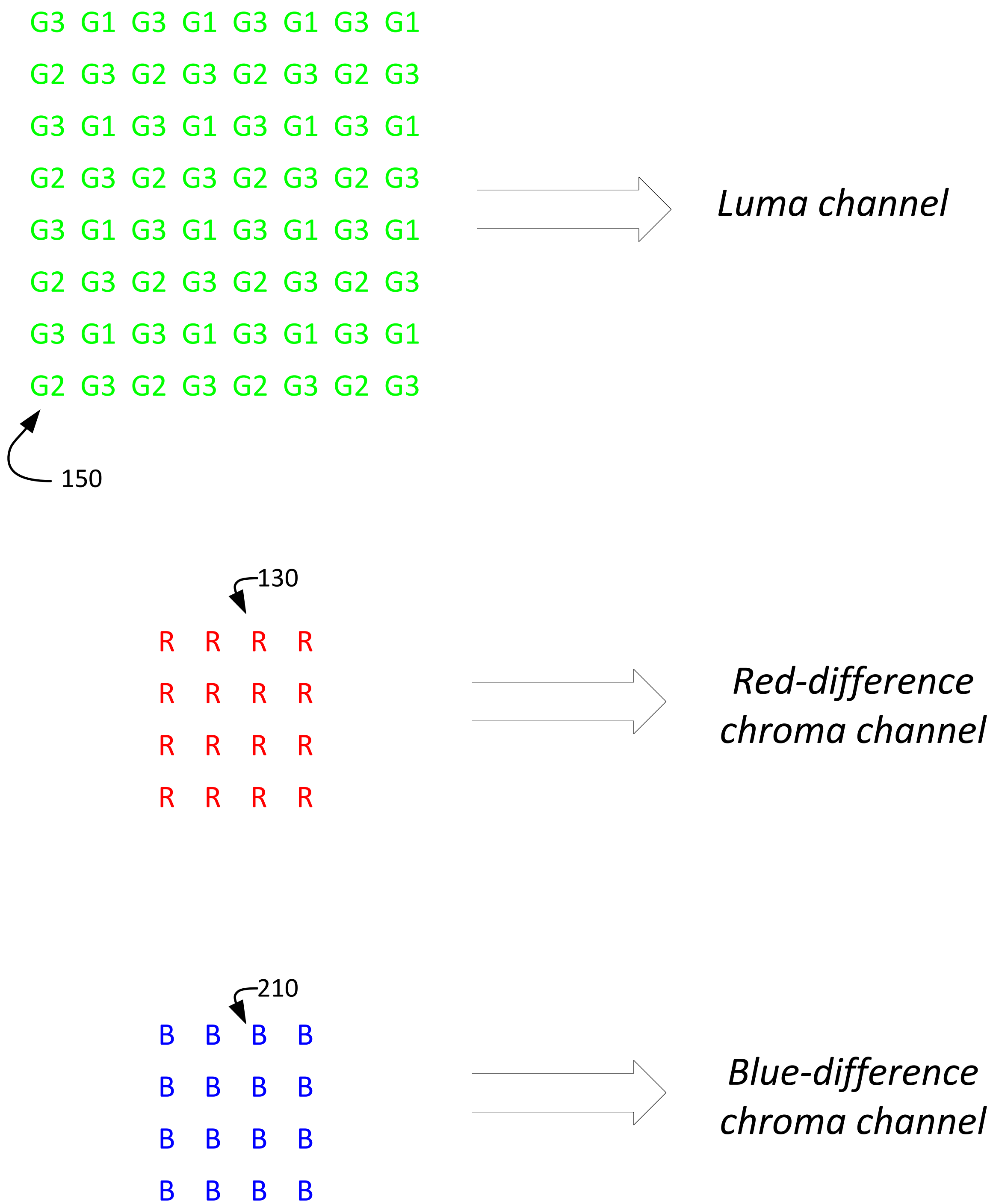
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
Luma channel
150
130
R R R R
R R R R
R R R R
R R R R
Red-difference chroma channel
210
B B B B
B B B B
B B B B
B B B B
Blue-difference chroma channel

FIGURE 2

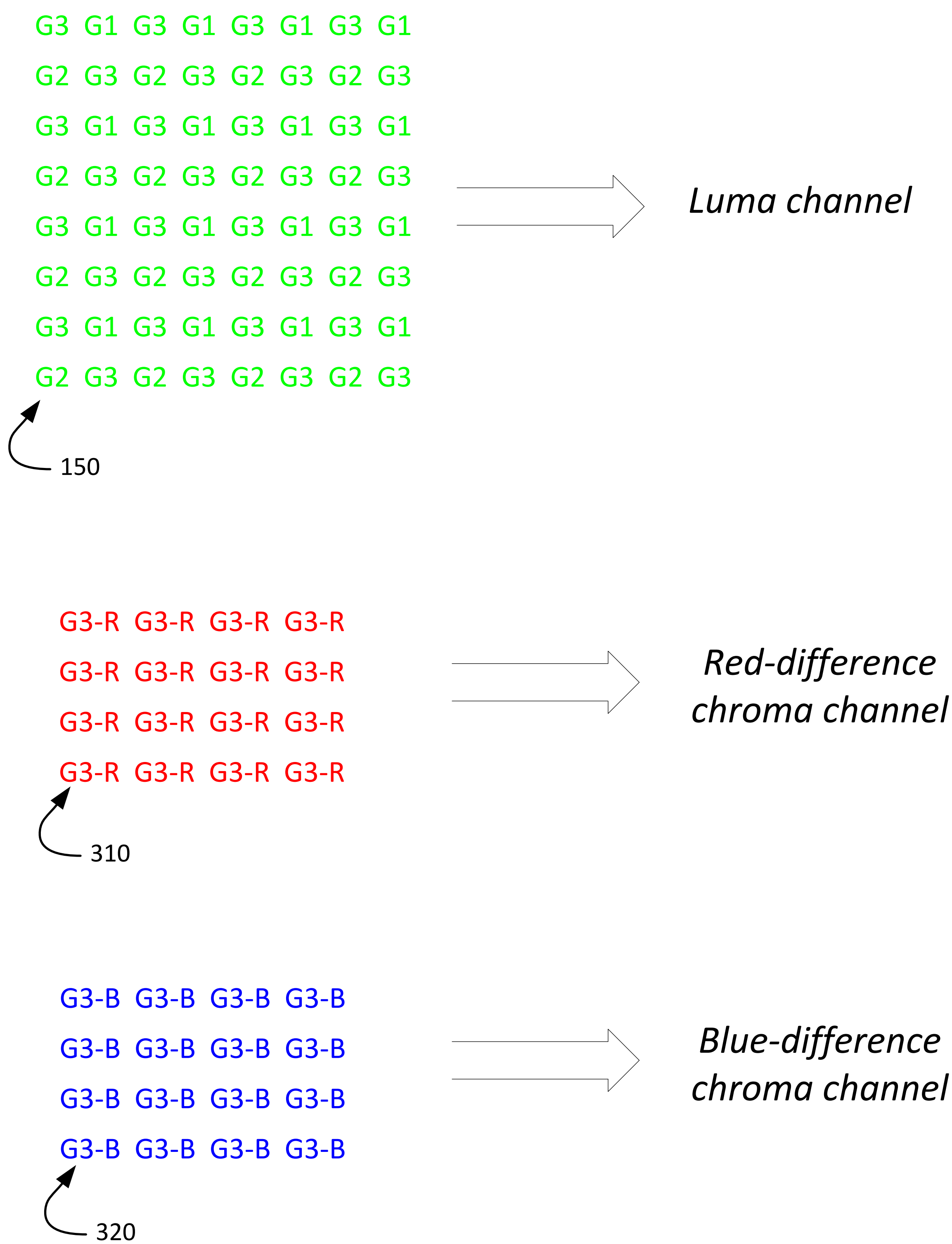
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
G3 G1 G3 G1 G3 G1 G3 G1
G2 G3 G2 G3 G2 G3 G2 G3
150
Luma channel
G3-R G3-R G3-R G3-R
G3-R G3-R G3-R G3-R
G3-R G3-R G3-R G3-R
G3-R G3-R G3-R G3-R
310
Red-difference chroma channel
G3-B G3-B G3-B G3-B
G3-B G3-B G3-B G3-B
G3-B G3-B G3-B G3-B
G3-B G3-B G3-B G3-B
320
Blue-difference chroma channel

FIGURE 3

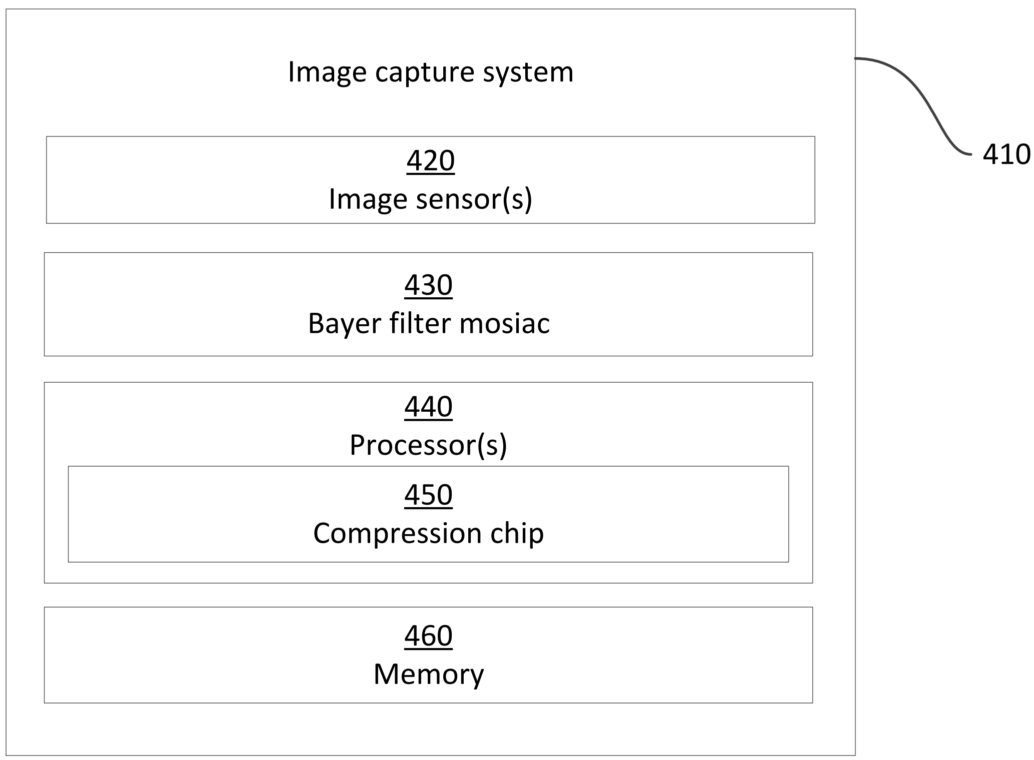
Image capture system
410
420
Image sensor(s)
430
Bayer filter mosiac
440
Processor(s)
450
Compression chip
460
Memory

FIGURE 4